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HYDRO-ELECTRIC INQUIRY COMMISSION

ENGINEERING DATA

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

STUDY OF CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

NIPISSING SECTION

OF THE

CENTRAL ONTARIO SYSTEM

To face frontispiece.

General Map Showing Location of

Generating Stations, Transformer Stations and Transmission Lines

of the

Hydro-Electric Power Commission of Ontario.

The area outlined in red shows the

Nipissing Section of the

Central Ontario System.

General Map Showing Location of

Generating Stations, Transformer Stations and Transmission Lines

of the

Hydro-Electric Power Commission of Ontario.

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The area outlined in red shows the

Eligibility Section of the

Central Ontario System.

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Toronto, Ontario,

January 12th, 1923.

Hydro-Electric Inquiry Commission,
W. D. Gregory, Esq., Chairman,
T O R O N T O, Ontario.

re Studies of Engineering Economics of the
Nipissing Section of the Central Ontario System of the
Hydro-Electric Power Commission of Ontario

Mr. Chairman and Gentlemen,-

In accordance with the letter to your Commission under date of November 4th, 1922, and your confirmation of the general instructions under date of November 15th, 1922, a study has been made of the engineering economics of the Central Ontario System of electrical generation and distribution and of the allied subsidiaries operated by the Hydro-Electric Power Commission of Ontario. The work has been done under the direct personal supervision of Mr. Frederick B. Brown, M.Sc., M.E.I.C., a partner in the firm of Walter J. Francis & Company, in accordance with your instructions.

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The subject has been discussed with Mr. Commissioner H. A. Ross in detail, and, generally, with Mr. Bower, the Secretary of your Commission, and constant communication has been maintained with the officials of the Hydro-Electric Power Commission of Ontario.

The reports of Messrs. Price, Waterhouse & Co., and of Messrs. Clarkson, Gordon and Dilworth have been used as the basis of the financial figures given herein, and reference has been made to the records of the Hydro-Electric Power Commission of Ontario where it was necessary to do so to prepare the diagrams.

It is understood that it is not within the scope of the instructions to examine into any of the legal aspects of the System nor discuss any of the Acts of the Legislature relating to it.

The necessary technical data has required considerable preparation, as much of it is only available in the operating records of the Hydro-Electric Power Commission of Ontario. The printed reports contain a part, but these have had to be supplemented by interviews with various officials and by searching the voluminous records both at the head office in Toronto and elsewhere.

The general plan under which the report of the studies is presented may be outlined as follows:

(1) A short review of the history and evolution of the System.

(2) A brief physical description of the System.

(3) A brief discussion regarding the characteristics of the local market.

(4) A discussion of progressive capital costs.

(5) Statistics regarding progressive revenues for various classes of service with discussion thereon.

(6) Statistics regarding progressive operating costs and fixed charges with discussion thereon.

(7) Statistics showing progressive and accumulated deficits or surpluses with discussion thereon.

(8) Analysis of progressive operating records and of unit revenues per kilowatt hour and per horse-power per annum and of unit costs per kilowatt hour and per horse-power per annum.

(9) A brief discussion of the various important points concerning the System.

The report included herewith as pages 4 to 50 inclusive refers in detail only to that portion of the Central Ontario System known as the Nipissing Section. The other part of the Central Ontario System is called the Central Ontario (Trent) Section, and has been dealt with in a separate document under date of January 5th, 1923.

Throughout the report diagrams have been included in the order of the text, referring to the Nipissing Section only, while the map included as a frontispiece shows the Section generally and its geographical relation to the Trent Section, and to all the other systems operated by the Hydro-Electric Power Commission of Ontario.

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NIPISSING SECTION
OF THE
CENTRAL ONTARIO SYSTEM

Frederick B. Brown, M. Sc.

Evolution and Development of the System.

The Central Ontario System consists of two distinct parts, namely, The Central Ontario (Trent) Section, and the Nipissing Section, operated under one system of accounting. The System is the result of the gradual development of electrical service by a number of independent companies from about the year 1900, which were finally amalgamated under the control of one company known as the Electric Power Company, Limited. Prior to March 1st, 1916, the Electric Power Company, Limited, consisted of twenty-two separate companies serving the districts with the usual electric light and power service as well as with gas and water in certain places. These companies were as follows: Auburn Power Company, Limited; Central Ontario Power Company; City Gas Company of Oshawa, Limited; Cobourg Utilities Corporation, Limited; Cobourg Water and Electric Company; Cobourg Gas, Light and Water Company; Eastern Power Company, Limited; Light, Heat and Power Company of Lindsay; Napanee Gas Company, Limited; Napanee Water & Electric Company; Nipissing Power Company, Limited; Northumberland Pulp Company, Limited; Oshawa Electric Light Company; Otonabee Power Company, Limited; North Bay Light, Heat & Power Company; Peterborough Light & Power Company, Limited; Peterborough Radial Railway Company; Port Hope Electric Light & Power Company; Seymour Power & Electric Company, Limited; Sidney Electric Power Company, Limited; Trenton Electric & Water Company,

Limited; Tweed Electric Light & Power Company, Limited.

About the year 1913, the activities of the Hydro-Electric Power Commission of Ontario were commencing to extend eastwards from Toronto into the Central Ontario district, and about the same time the activities of large private power companies were extending westwards from Montreal and eastern Ontario. This finally resulted in an agreement between the Electric Power Company, Limited, and the Government of the Province of Ontario, whereby the Government purchased all of the assets and undertakings of the Electric Power Company, Limited, under an agreement dated March 10th, 1916, which arranged for the transfer of the properties of the Electric Power Company, Limited, as at March 1st, 1916, the consideration being the sum of $3,350,000.00, in ten-year 4 per cent. bonds of the Ontario Government. This arrangement was confirmed by the assent of the Lieutenant-Governor being given to the Central Ontario Power Act on April 27th, 1916. It was arranged that the management of the properties so taken over would be vested in the officials of the Electric Power Company, Limited, up to June 1st, 1916, since which time the Hydro-Electric Power Commission of Ontario has been operating the System on behalf of the Province and has extended the service beyond the limits of 1916, until at the present time it is supplying power in about thirty municipalities and townships as well as to a large number of individual consumers at different points on the System.

Description of the System.

The Central Ontario System comprises two distinct portions, one known as the Central Ontario (Trent) Section, which extends from Whitby on the west to

and including the city of Kingston on the east, and from the Lake Ontario water-front north as far as Lindsay. The Nipissing Section supplies North Bay, Callander, Powassan and Nipissing. For the purposes of discussion and analysis the two Sections of the System have been considered separately. The discussion of the Central Ontario (Trent) Section has been presented under date of January 5th, 1923, and the report on the Nipissing Section is presented herewith.

The map included as a frontispiece shows the whole of the transmission systems of the Hydro-Electric Power Commission with the location of generating stations, high tension transformer stations, high tension transmission lines and low tension transformer stations clearly indicated, and shows the various systems in their relation to one another. The tinted portion of the map indicates the Nipissing Section, and shows the relation of this Section to the Trent Section.

The map included as page 7 shows the Nipissing Section on a larger scale than the frontispiece. It also gives the names of the principal centres concerned, as well as the location of the undeveloped power sites and storage dams on the South River, and the sites of the proposed developments on the French River.

Speaking generally, the System consists of a hydro-electric generating plant on the South River, transmission lines feeding four municipalities, and distribution systems in each of these four places. The System includes a steam-driven stand-by plant in North Bay.

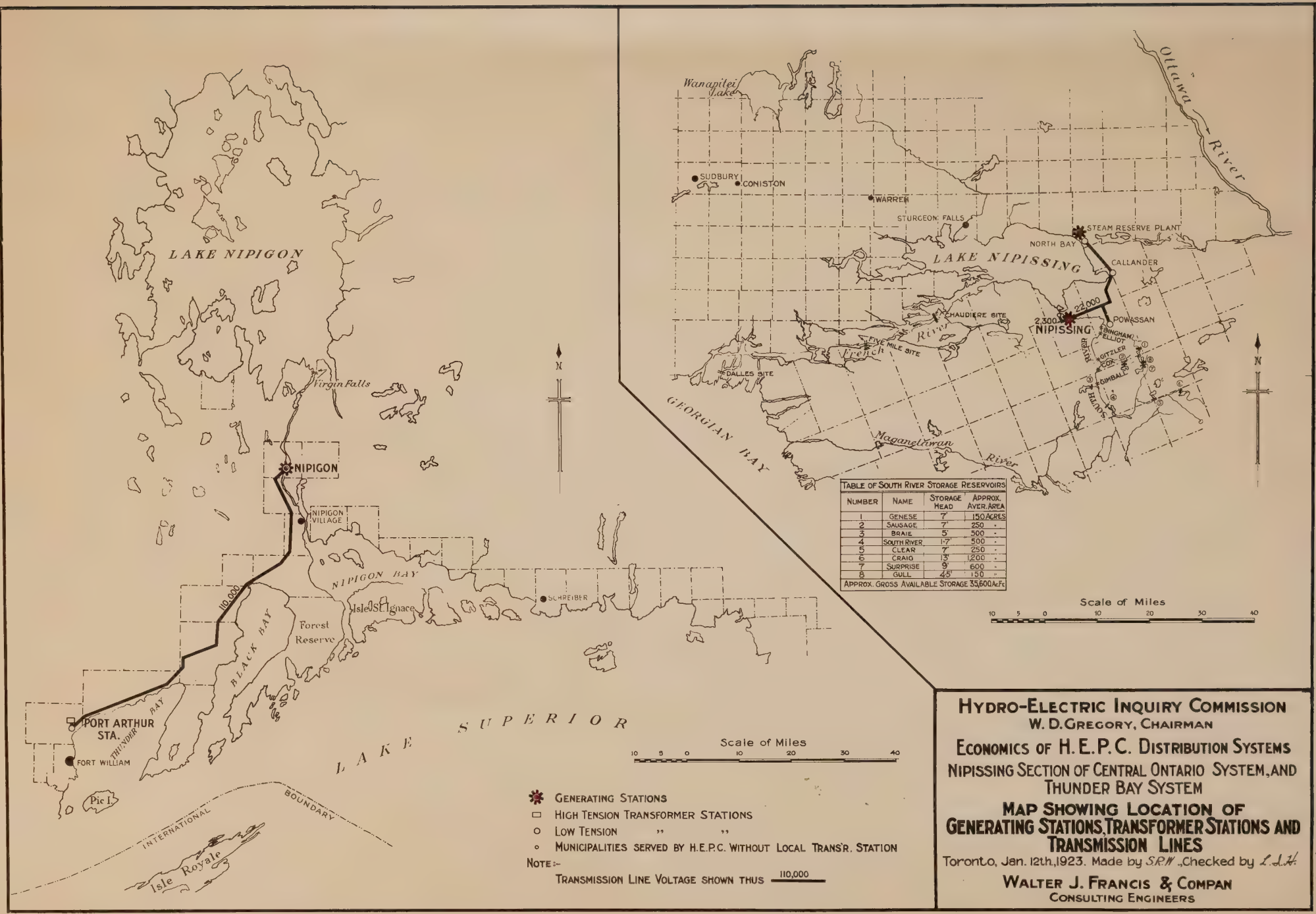

TABLE OF SOUTH RIVER STORAGE RESERVOIRS			
NUMBER	NAME	STORAGE HEAD	APPROX. AVER. AREA
1	GENESE	7'	150 ACRES
2	SAUSAGE	7'	250 "
3	BRAIE	5'	500 "
4	SOUTH RIVER	1·7'	500 "
5	CLEAR	7'	250 "
6	CRAIG	13'	1,200 "
7	SURPRISE	9'	600 "
8	GULL	4·5'	150 "
APPROX. GROSS AVAILABLE STORAGE 33,600 AC.FT.			

HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

NIPISSING SECTION OF CENTRAL ONTARIO SYSTEM, AND THUNDER BAY SYSTEM

MAP SHOWING LOCATION OF GENERATING STATIONS, TRANSFORMER STATIONS AND TRANSMISSION LINES

Toronto, Jan. 12th, 1923. Made by S.P.W. Checked by L.J.H.

WALTER J. FRANCIS & COMPAN
CONSULTING ENGINEERS

(7)

Generating Station and Other Sources of Power Supply.

The present source of electrical energy is a plant on the South River near the village of Nipissing, known as the Nipissing plant, and being situated about twenty miles from North Bay. The South River drains an area of about 294 square miles above this point. The character of the stream is such that in past years the variations in the flow were very marked from season to season and it was necessary to use a steam-plant auxiliary during several summer and winter months when the river flow was low. In the year 1920 eight storage dams were constructed at the outlets of small lakes on the watershed ranging in surface area from 150 acres to 1,200 acres. The dams are of timber-crib, rock-fill construction, sheeted on the face and puddled, each having a single sluiceway containing stop logs for flow regulation. The storage heads range from about 2 feet to 13 feet, and the total storage impounded is approximately 35,000 acre-feet. The regulated flow of the South River at the present time is stated to be in the neighborhood of 200 cubic feet per second. A complete system of telephone communication has been installed at the power plant and the various storage dams to facilitate water control.

The Nipissing plant originally consisted of two units, each of about 1,000 horse-power wheel capacity connected to generators each rated at 450 K.V.A., thus having a total nominal effective output of about 1,200 horse-power, when it was taken over by the Ontario Government in 1916. In 1921 one of these two units was re-modelled by changing the design of the runners so as to develop 1,400 horse-power instead of 1,000 horse-power. New seal rings were put on, and the connections between the guide vanes and the governor were strengthened.

New butterfly valves were also placed in the power house instead of the old gate valves. A new generator was purchased from the Canadian Westinghouse Company, having a maximum rating of 1,400 K.V.A. at 70 per cent. power factor. This machine is a 3-phase, 60-cycle, 2,300-volt, 450 r.p.m. horizontal water-wheel type generator.

Originally the plant contained three 500-K.V.A. transformers, but in 1921 new transformers, manufactured by the Packard Electric Company of St. Catharines were installed. These are three 900-K.V.A. single phase, 60-cycle, oil insulated, water cooled transformers, 2,300 to 23,000, 24,000, 25,000, 26,000 volts. The old transformers were disconnected but are available and it is stated that they will probably be used in the Sinclair development in 1923.

At the present time, therefore, the Nipissing generating station consists of one 450-K.V.A. unit, and one 1,400-K.V.A. unit, and may be rated nominally at about 2,000 horse-power.

In the town of North Bay, there is a small steam-driven electric station having a capacity of about 625 horse-power. This steam plant has had to be operated to a considerable extent during the past few years, but is by no means an economical source of power. Its operating costs are very high.

There is also a small power house near Powassan which has been abandoned and is no longer available as a source of power.

Undeveloped Power Sites, South River.

The Hydro-Electric Power Commission acting as trustee for the Ontario Government has at present certain unproductive power rights at a number of

power sites on the South River, as indicated on page 7. These are as shown in the following table furnished by the Hydro-Electric Power Commission:

Table of Undeveloped Power Sites

	Bingham	Elliot	Gitzler	Cox	Gimball
1. Name of River	South	South	South	South	South
2. Drainage Area Square Miles	261	230	190	160	150
3. Minimum Precipitation per Annum in Inches	30.9	30.9	30.9	30.9	30.9
4. Mean Precipitation per Annum in Inches	34.4	34.4	34.4	34.4	34.4
5. Minimum Mean Monthly Run Off C.F.S.	a 80	a 80	a 80	a 80	a 80
6. Mean Run Off per Annum C.F.S.	a 420	a 420	a 420	a 420	a 420
7. Minimum Available Head Feet	44	31	71	65	30
8. Mean Available Head Feet	47	31	71	78	30
9. Years of Precipitation Records	1916-1919	1916-1919	1916-1919	1916-1919	1916-1919
10. Years of Gauging Records	1914-1921	1914-1921	1914-1921	1914-1921	1914-1921
11. Water Horse-power Mean	b 1060	c 1150	2160	1930	700
12. Water Storage Million Cubic Feet	965	965	965	965	965

a At metering section at Gough's Bridge drainage area 294 square miles.
b Based on minimum flow under present regulation 200 C.F.S.
c Based on flow proportional to drainage area relation to 294.

A study of the above table shows that the site at Bingham is closest to the Nipissing plant, and that of the others, the Elliot and Gimball sites are of comparatively small size. The two sites called Gitzler and Cox have heads more

than double those at the Elliot and Gisball sites and would provide from 3,000 to 4,000 horse-power between them.

The Bingham site is about to be developed to serve the growing needs of North Bay and the other power consumers. The estimated cost of developing this site is about $189,000.00, made up of $123,000.00 classified as hydraulic items, and $66,000.00 of electrical items. It is proposed to use the generator which was removed from the Nipissing plant in 1921 as one of the units for the Bingham site, connecting it to a new turbine. A second similar turbine is to be installed ready for connection to a second 450-K.V.A. generator. This generator will probably be the 450-K.V.A. unit still running at the Nipissing power house, or may possibly be the 400-kilowatt unit from the steam plant at North Bay.

If the remaining 450-K.V.A. generator from the Nipissing plant be removed and installed at the Bingham site, it is proposed to rebuild the pipe line at the Nipissing plant to permit of remodelling the second unit so as to be similar to the one installed in 1921, namely, a 1,400-horse-power water wheel and a 1,400-K.V.A. generator.

The estimates for 1922-1923 construction submitted by the Hydro-Electric Power Commission to the Ontario Legislature on May 25th, 1922, and subsequently authorized by the Legislature, provide for a total expenditure of $350,000.00 in connection with the Nipissing Section of the Central Ontario System. It has been stated that this figure includes the amount of $189,000.00 above outlined for the work at the Bingham site and $50,000.00 for transmission lines. The balance, namely $111,000.00, is apparently for work at the Callander station,

the new pipe line at Nipissing, remodelling the second water wheel at Nipissing, a complete new generator at Nipissing, and miscellaneous items throughout the Section. It is understood this also includes additional capacity in the distribution system at North Bay to take care of the heavy stove loads in that place.

When all of the above changes will have been completed, probably by the autumn of 1923, the Nipissing Section will have two power plants on the South River within a comparatively short distance of one another. The Nipissing station will then consist of two units, each of about 1,400 horse-power capacity, or 2,800 horse-power in all, while the Bingham plant will consist of two units, each of about 450 horse-power capacity, or 900 horse-power in all. The total output of the two stations will be approximately 3,700 horse-power under commercial conditions.

If the Gitzler and Cox sites were developed, the commercial output of these two together would probably be between 3,000 and 4,000 horse-power, which would make the total power from the South River altogether about 7,000 horse-power, neglecting the Elliot and Gimball sites. If these two latter sites be developed the total available power might be increased by about 1,500 horse-power, making about 8,500 in all, but it is probable that the capital costs of developing these two small sites would be prohibitive.

Possible Power Sites, French River.

Much discussion has taken place in the Nipissing district regarding the development of certain power sites on the French River, as indicated on page 7,

using Lake Nipissing as a storage reservoir. There is a total available head between Lake Nipissing and Georgian Bay of about 60 feet. Any development in this section must follow the plans of the Department of Railways and Canals, Canada, in connection with the proposed development of the Georgian Bay Ship Canal. This being the case, there are three possible sites for power plants, namely, the Chaudiere, the Five-Mile, and the Dalles. The present head at the Chaudiere site, which is about 47 transmission miles from North Bay, is approximately 28 feet. This could be raised to 32 feet or 34 feet by raising the level of Lake Nipissing to the proposed regulated level under Georgian Bay Canal conditions. If the Five-Mile site be developed it would cut down the head at the Chaudiere site by 10 feet so that the ultimate head at the Chaudiere site would be from 22 feet to 24 feet. The Five-Mile site could also be developed for an ultimate head of from 22 feet to 24 feet, while the head at the Dalles site could only be 10 feet or 12 feet, and would probably prove uncommercial.

A dam stated to have cost about $300,000.00 has been built in connection with the Chaudiere works by the Federal Government, and this is available as part of the proposed hydro-electric power construction at that point. The engineers of the Hydro-Electric Power Commission estimate that the installation at the Chaudiere site should consist of three vertical units of approximately 4,000 horse-power each under 30-foot head, the units to operate at about 150 r.p.m., and to be of the new high-speed type similar to those recently installed by the Winnipeg Power Company. Later, when the Five-Mile site would have been developed, the capacity of the Chaudiere would be reduced to about 10,000

horse-power. The Five-Mile site would be developed for about 8,000 or 9,000 horse-power. The development of the Chaudiere site would include the excavation of about 50,000 cubic yards of rock, and the total estimated cost for the complete development, including all hydraulic and electrical items, and making allowance for the existing dam, is stated to be about one and one-third millions of dollars. These figures are stated to be based on 1922 prices, and include an allowance for contingencies.

The development of the French River sites would only be feasible if considerably larger loads than are now in sight could be obtained.

Transmission Lines.

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The transmission lines of the Nipissing Section consist of about 25 miles of 22,000-volt lines as indicated on the map on page 7. These are all wooden pole construction and present no extraordinary features.

Transformer Stations.

Power is distributed from the generating station to three high-tension transformer stations located at North Bay, Powassan and Callander, where the voltage is reduced from 22,000 volts to 2,200 volts for local distribution.

Electrical Distribution Systems.

Callander, Powassan and Nipissing are supplied with electrical energy by the Hydro-Electric Power Commission of Ontario, acting as trustee for the

Province, at rates agreed between the customers and the Commission. The town of North Bay is supplied at fixed rates governed as to their maximum by a contract and a franchise granted to the Electric Power Company, Limited, on December 18th, 1915, several months prior to the date of purchase by the Ontario Government. In all of these places power is sold retail by the Hydro-Electric Power Commission which operates the distribution systems as well as the generating plants and transmission lines. This practice is similar to that in the fifteen municipalities of the Central Ontario (Trent) Section as outlined in the report of January 5th, 1923, and is different from the practice in most of the other systems operated by the Hydro-Electric Power Commission of Ontario, where the usual practice is for the municipality to do the retail distribution. The accounting for the municipalities of the Nipissing Section is included in the general accounts of the Commission for the System, and the details in the various municipalities are not given in the annual reports.

Characteristics of Market.

Population Served and Percentage of Consumers to Population.

The district served by the Nipissing Section of the Central Ontario System is both urban and rural, but the bulk of the load is in the town of North Bay.

The population of North Bay is now said to be between 12,000 and 13,000, while the population of the other municipalities is comparatively small. The total population of the district served is said to be about 15,000.

The table below gives in detail the number of consumers at the end of the fiscal year 1921 in the places served by the Section, the approximate horse-power billed to each place in 1921, the kilowatt hours consumed in each place in 1921, together with the average horse-power and average kilowatt hours per consumer. The figures are useful for comparison with other systems although they should be used with caution.

Table of Market Statistics

Municipality	Population 1921	Consumers 1921	Percentage Consumers to Population	H.P. Billed 1921	Kilowatt Hours 1921	Billed H.P. per Consumer	Kilowatt Hours per Consumer
North Bay	10,924	2,535	23.2	1,192	4,318,066	0.47	1,703
Callander	650	118	18.2	43	70,240	0.36	595
Powassan	599	161	26.9	94	178,040	0.58	1,106
Nipissing	100	13	13.0	3	5,420	0.23	417
Total	12,273	2,827	23.0	1,332	4,571,766	0.47	1,618

The average horse-power billed per consumer and per capita, and the average kilowatt hours per consumer and per capita are as follows:

Average H.P. Billed per Consumer, 1921, 0.47
Average H.P. Billed per Capita, 1921, 0.11
Average K.W.H. Billed per Consumer, 1921, 1,618
Average K.W.H. Billed per Capita, 1921, 373

Growth of Market.

Since the Hydro-Electric Power Commission of Ontario took over the management of the Nipissing Section in 1916, the growth of the Section has been

steady, the peak load having increased about ten per centum per annum.

The peak loads on the system were as follows, the figures being given in horse-power: 1916, 1,153; 1917, 1,166; 1918, 1260; 1919, 1,380; 1920, 1,540; 1921, 1,696; 1922, 1,696.

By the contract between the Electric Power Company, Limited, and the town of North Bay, the Company agreed to develop 3,500 horse-power for the use of the town, and to supply all the needs up to this amount during the life of the contract, which was made for ten years from December 15th, 1915. Until 1921 the available capacity including the steam plant was not more than 1,825 horse-power, with considerable periods of low water when the available power was much less. Since 1921 the capacity including the steam plant has been 2,625 horse-power as a maximum. A number of complaints have been made in which it was stated that the service, in North Bay particularly, was not in accordance with the contract, and that there was a considerable shortage of power from time to time. It is apparently the case that in the past two years North Bay could have used more power than was actually available, it being estimated that in 1922 about 400 or 500 horse-power in addition to that available might have been marketed.

The geographical situation of North Bay is such that the question of fuel is very important and the consequent use of electricity for cooking purposes has been remarkably rapid. It is stated by officials of the Hydro-Electric Power Commission of Ontario that North Bay has more electric stoves per capita than any other municipality served by the Commission. It is also stated that the low voltage and the lack of satisfactory service in North Bay is due partly

to insufficient copper in the distribution system within the limits of the town, and due partly to lack of power at the generating station.

It may be reasonably deduced from the figures submitted that the present total power demand for North Bay is in the neighborhood of 2,000 horse-power, possibly a little more, and that this amount of power could be marketed without any large increase in the number of consumers. It has been stated freely that a number of industries have decided against locating in North Bay because of their fear that sufficient power would not be available. Taking everything into consideration it would appear that with the complete development of the Nipissing plant and the Bingham plant so as to have available from 3,500 horse-power to 4,000 horse-power, the reasonable needs of the Nipissing Section would be served for possibly five years of ordinary growth. Any extraordinary demand such as the establishment of new industries in North Bay, would entirely change the aspect of the future market.

This leads naturally to a discussion of the future power market of the district, and the ultimate sources of supply which are available to meet additional demands.

There has been considerable discussion as to the possibilities of supplying Sudbury with power from the French River sites. The present market in Sudbury is not sufficiently extensive to warrant the development of even the Chaudiere site alone, but there is a possibility of making this site commercially feasible provided the present load in Sudbury could be augmented by the addition of the normal demands of the Mond Nickel Company, located near Coniston, a few miles east of Sudbury.

There are two possible routes for transmitting power from the French River to North Bay and to Sudbury. If North Bay alone were to be served, the shortest distance is along the southerly shore of Lake Nipissing to Nipissing power plant and thence following the present transmission lines to North Bay, a total distance of about 47 miles. If Sudbury and Coniston were to be served by this route, an extension from North Bay to Sudbury would be required along the northerly shore of Lake Nipissing. This would be about 79 miles in length, making the total transmission distance to Sudbury by this route about 126 miles.

The other route would be along the westerly end of Lake Nipissing, northwards to the Canadian Pacific Railway near Warren, a distance of about 28 miles, and thence east to North Bay along the north shore of Lake Nipissing, a distance of about 43 miles, and westwards from Warren to Coniston about 28 miles and to Sudbury about 8 miles further on. This route would therefore be 71 miles to North Bay, 56 miles to Coniston and 64 miles to Sudbury, with a total length of lines of about 107 miles.

The southerly route would be more advantageous for North Bay alone, while the northerly route would be better if all the district as far as Sudbury is to be served.

It is understood that the Mond Nickel Company has recently installed a steam-driven plant of a capacity of about 8,000 horse-power, and it was stated at a recent hearing of the Hydro-Electric Inquiry Commission that the cost per horse-power per annum from this plant would be about $168.00. If this load were available the economic aspect of the proposed development of the Chaudiere site would be entirely changed, and it is probable that a load of this size

could easily carry all the operating costs and fixed charges of a development at the Chaudiere, and the total power billed would be only a fraction of the above mentioned annual cost per horse-power. If such a load be found the additional power available for North Bay would provide for many years of ordinary growth, and would permit North Bay welcoming a number of new industries even of considerable magnitude.

As an alternative to the development of some of the South River sites and the French River sites, it has been proposed to transmit power 50 miles or more from the Muskoka System, but the engineers of the Hydro-Electric Power Commission state that the power available in the Muskoka district will be needed for the operation of the Severn System. It would therefore appear that this alternative is not feasible.

The use of such a heavy proportion of electric stoves in North Bay has undoubtedly been a large factor in the present state of the service, and the further development of stove loads should be discouraged until a considerable excess of power has been made available by further development. It was hoped that the steam plant formerly operated would not again be called upon, but the engineers of the Hydro-Electric Power Commission state that they are at the present time seriously considering operating the steam plant to meet the demand of the present winter season.

Summing up the local situation it therefore seems that the development of Bingham, and the re-modelling and extension of the Nipissing plant will provide for normal growth for the next few years, that the Gitzler and Gimball sites are available provided the increase in load is gradual and small, and the costs

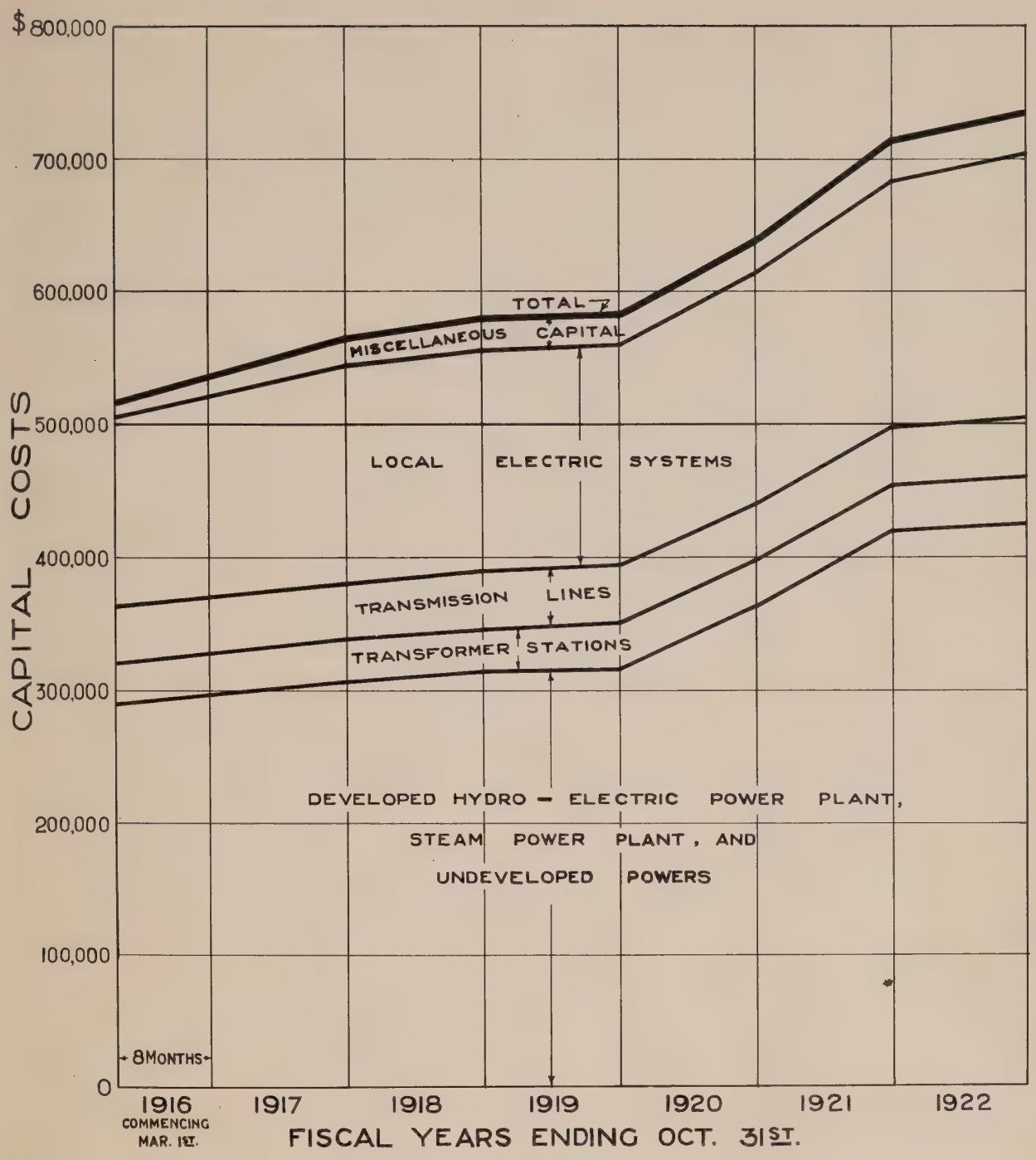
of development would not prove too high, and that finally there are two sites on the French River of considerable magnitude which may be economically developed provided large blocks of power are available at one time.

Capital Costs.

The table following and the sheet of curves on page 22 show the progressive capital costs for the Nipissing Section. These have been prepared in a similar manner to those already described in connection with the Central Ontario Section, and require no further comment. They are from the report of Messrs. Price, Waterhouse & Co. under date of October 26th, 1922, referring to the end of the fiscal year, October 31st, 1921. The figures for 1922 are based on the Clarkson report to September 30th, 1922. The miscellaneous capital costs are approximately one-seventeenth of the total charged against both Sections of the System, being derived as described under the discussion of capital costs for the Central Ontario (Trent) Section.

Table of Progressive Capital Costs

Capital Assets (including intangible values)	As at March 1st, 1916	1917	As at Year Ending October 31st, 1918	1919	1920	1921	1922
Power Development and Steam Plant	291,162	307,159	314,621	315,998	363,298	419,734	426,000
Transformer Stations	30,914	31,848	31,826	35,492	35,492	35,492	36,000
Transmission Lines	43,322	43,322	43,322	43,322	43,322	43,322	43,000
Local Electric Systems	141,429	164,436	167,800	165,133	170,679	184,237	199,000
Miscellaneous Capital, Tools, Supplies, etc.	12,508	21,637	25,879	24,933	27,293	32,126	32,000
Total	$519,335	$568,202	$583,448	$584,878	$640,084	$714,911	$736,000



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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

PROGRESSIVE CAPITAL COSTS

Toronto, Jan. 12th, 1923 Made by Checked by

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Purchase Price of Central Ontario System.

The amount agreed upon between the Ontario Government and the Electric Power Company, Limited, as the purchase price of the Central Ontario System was $8,350,000.00.

In 1914, the engineers of the Hydro-Electric Power Commission of Ontario had made a valuation of the assets of the System, and this was applied after the purchase had been made in order to sub-divide tangible from intangible values. Based on the 1914 appraisal, the replacement values of the tangible properties, including additions to March 1st, 1916, were stated to be $5,487,659 for fixed capital, and $184,999 of material and supplies, leaving $2,677,342, as the amount considered as the value of the intangibles acquired in connection with the purchase of the System. The sub-division of these amounts as amongst the various properties concerned is as shown in the following table:

Table of Sub-division of Purchase Price

	Tangibles	Intangibles	Total
Central Ontario Section			
Developed Powers	$1,822,890	$952,500	$2,775,390
Undeveloped Sites and Stand-by Plants	323,731	963,212	1,286,943
Transformer Stations	632,406	141,426	773,832
Transmission Lines	804,080	175,962	980,042
Local Electric Utilities	637,992	160,670	798,662
Gas, Water and Street Railway	753,670	164,937	918,607
Pulp Mill	91,223	19,964	111,187

(Table continued on next page)

Table of Sub-division of Purchase Price (continued)

	Tangibles	Intangibles	Total
Nipissing Section.			
Power Development and Steam Plants	$ 229,011	$ 62,151	$ 291,162
Transformer Stations	25,072	5,842	30,914
Transmission Lines	35,136	8,186	43,322
Local Electric Utilities	118,937	22,492	141,429
Both Sections.			
Materials and Supplies	184,999	-	184,999
Tools and Equipment	13,511	-	13,511
Total	$5,672,658	$2,677,342	$8,350,000

The allocation of the intangibles to the various portions of the System was apparently made on a more or less arbitrary basis for accounting purposes, but it is understood that all intangibles are excluded in every instance in estimating property values upon which depreciation allowances are calculated.

From the figures in the above table, a sub-division of the various items belonging to the Nipissing Section can be readily separated if desired.

Power Data.

The table below and the sheet of curves on page 26 have been prepared to show the horse-power data in connection with the Nipissing Section of the Central Ontario System.

Table of Horse-power Developed, Consumed, Billed, etc.

	As at March 1st, 1916	Fiscal Years Ending October 31st, 1917	1918	1919	1920	1921	1922
Developed Hydro-Electric	1,200	1,200	1,200	1,200	1,200	2,000	2,000
Developed Steam Plant	625	625	625	625	625	625	625
Total	1,825	1,825	1,825	1,825	1,825	2,625	2,625
Consumed	-	-	-	513	659	700	766
Billed	-	-	-	1,117	1,294	1,332	1,496
Average of Twelve Monthly Peaks	1,011	999	1,068	1,215	1,323	1,359	1,517
Maximum Yearly Peak	1,153	1,666	1,260	1,380	1,540	1,696	1,696

The various classes of horse-power shown in the table and on the curves are parallel to those already described in detail for the Central Ontario (Trent) Section and require no further comment.

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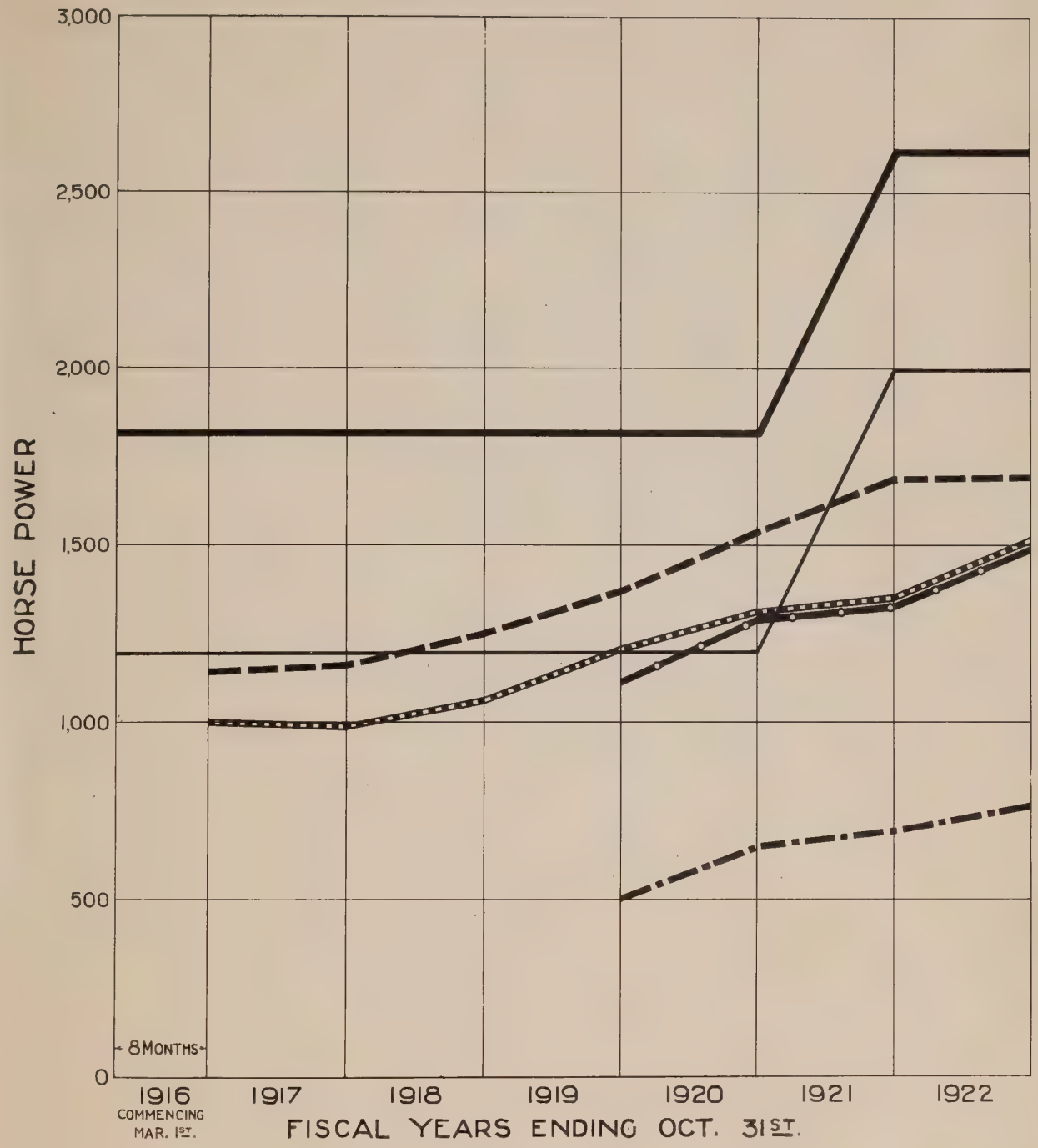
Capital Costs per Horse Power Developed.

The table on page 27 and the diagram included as page 28 indicate the fractional capital costs per rated plant horse-power developed, at different points of delivery. This table and the sheet of curves were derived from the progressive capital cost figures and the horse-power data given previously in the report. The curves indicate the capital cost per rated plant horse-power, with the spaces between each of the curves showing that portion of the total delivered capital cost per horse-power chargeable against each of the items of the table, as follows:



HYDRO-ELECTRIC POWER DEVELOPED PLUS STEAM PLANT
HYDRO-ELECTRIC POWER DEVELOPED
MAXIMUM YEARLY H.P. PEAKS
AVERAGE OF 12 MONTHLY PEAKS
HORSE POWER BILLED
AVERAGE H.P. CONSUMED

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ECONOMICS OF H.E.P.C. DISTRIBUTION SYSTEMS

CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

HORSE POWER DATA

Toronto, Jan. 12th., 1923 Made by H.W.D. Checked by W.S.W.

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Table of Capital Costs per Rated Plant Horse-power Developed

	As at March 1st, 1916	Fiscal Years Ending October 31st, 1917	1918	1919	1920	1921	1922
Power Development and Steam Plant	159.54	168.31	172.40	173.14	199.06	159.90	162.28
Transformer Stations	16.95	17.41	17.45	19.45	19.45	13.52	13.71
Transmission Lines	23.74	23.74	23.74	23.74	23.74	15.50	16.38
Local Electric Systems	77.49	90.10	91.94	90.48	93.52	70.19	75.81
Miscellaneous Capital, Tools, Supplies, etc.	6.85	11.85	14.18	13.64	14.96	12.20	12.20
Total	$284.57	$311.41	$319.71	$320.45	$350.73	$272.31	$280.38

Probable Conditions at the End of 1923.

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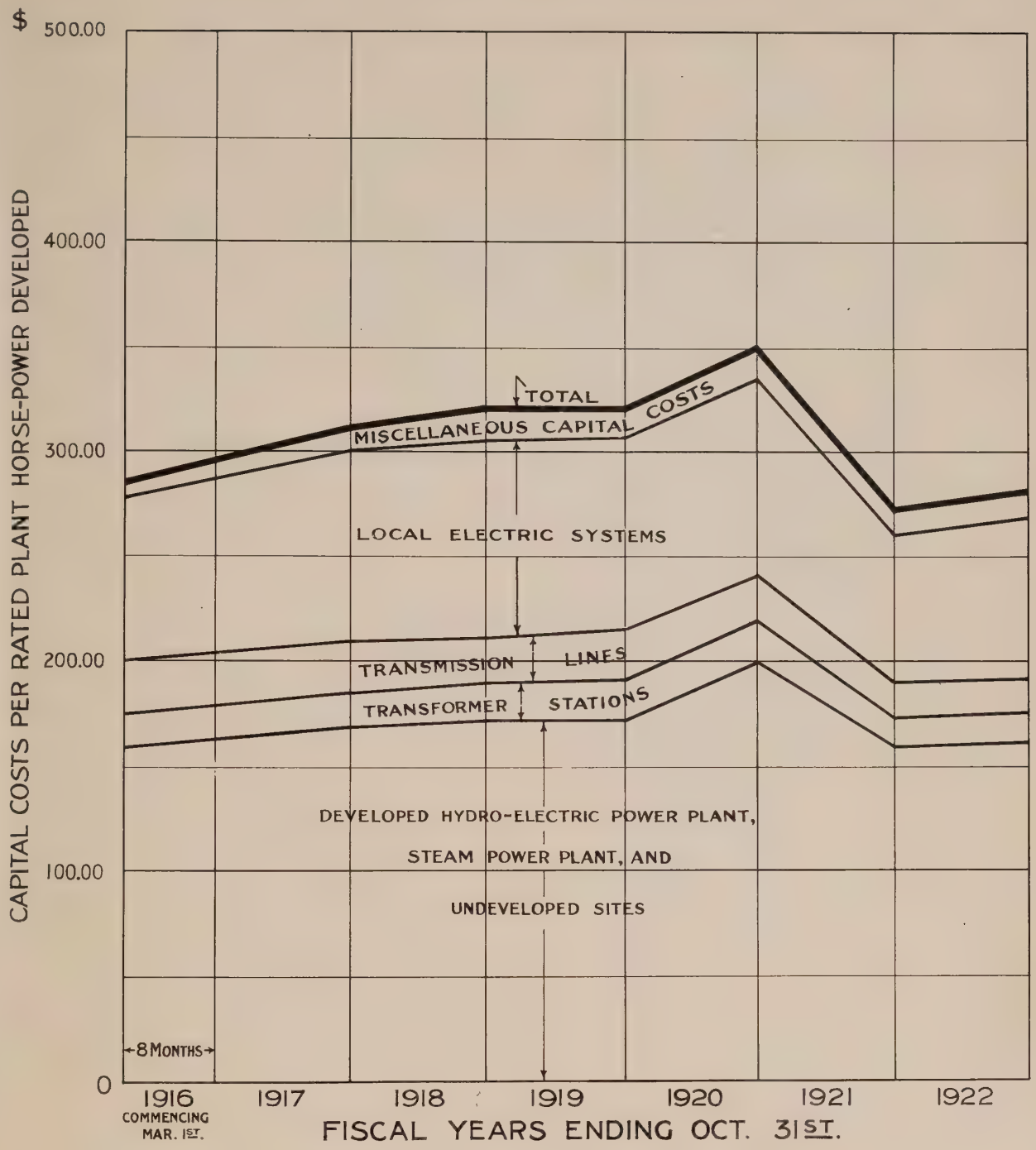
If the estimated sum of $350,000 be spent during 1923 on the development of the Bingham site and the enlargement and re-modelling of the Nipissing plant and the distribution system, the total capital costs for the Nipissing Section will be slightly over $1,000,000, while the total available rated plant horse-power developed will be between 3,500 and 4,000 horse-power, or about 3,700 horse-power. The figures for 1923 will therefore probably show a marked difference from those of 1922, but as the actual sub-division of the proposed expenditure can not be correctly stated until after the expenditures will have been made, it is impossible to show correct figures for 1923 at the present time.

Total Annual Revenues.

The total annual revenues of the Nipissing Section have been deduced from the figures given in Price, Waterhouse & Co. report, and the Clarkson report



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CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

CAPITAL COSTS PER H. P. DEVELOPED

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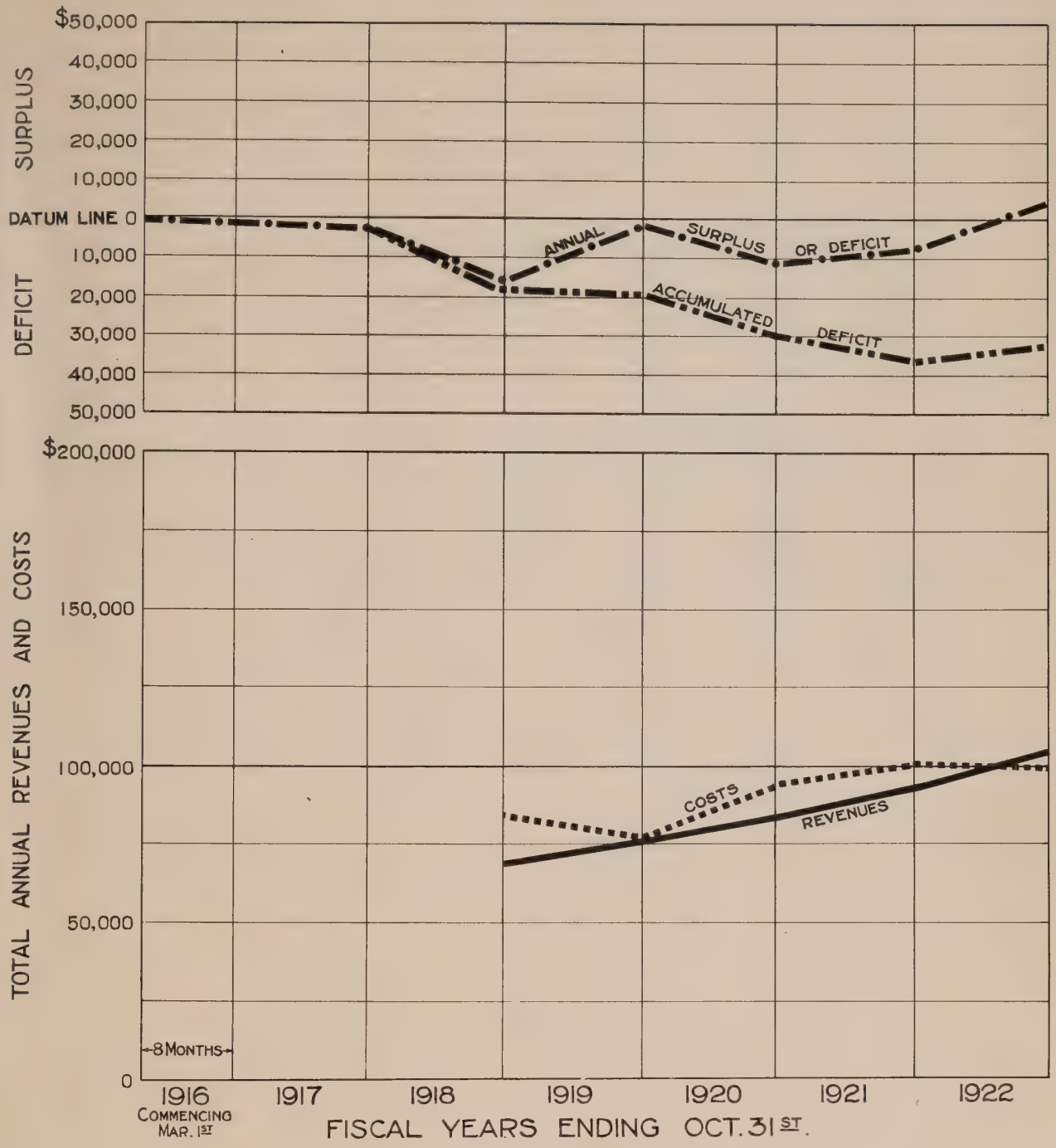
already mentioned. They have been considered as if the Nipissing Section were operating as a private company, and have not been separated as between the power department and the municipal department for similar reasons to those stated in the discussion of the Central Ontario (Trent) Section, namely, because the retail sales department of this Section is essentially part of the power department.

The sheet of curves included as page 30 indicates the total annual revenues on this basis. The figures from which the curves are plotted are as follows:

Period	Total Revenues per Annum
March 1st, 1916 to October 31st, 1917	$117,668.04
Year ending October 31st, 1918	69,726.90
Year ending October 31st, 1919	77,163.35
Year ending October 31st, 1920	84,803.75
Year ending October 31st, 1921	94,457.64
Year ending October 31st, 1922	105,420.48

Total Annual Costs of Power.

The table on page 31, and one of the curves on page 30, show the total costs of power compared with total revenues for each fiscal year from 1917 to 1922 inclusive. These costs include the total for both the wholesale and retail departments as if they were operating as one system. The figures for these costs were derived from the report of Price, Waterhouse & Co. and that of Clarkson, Gordon & Dillworth, already mentioned. The items in the table, namely operating costs, maintenance, overhead and general expense, interest, renewals and contingencies, were derived in a similar manner to the corresponding items



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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

TOTAL ANNUAL REVENUES AND COSTS AND ACCUMULATED DEFICITS

Toronto, Jan 12th, 1923. Made by G.E.B., Checked by L.d.J.

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for the Central Ontario (Trent) Section. The figures are as follows:

Table of Total Yearly Costs of Power

	1918	1919	1920	1921	1922
Operating Costs	$21,929	$18,081	$28,577	$25,177	( )
Maintenance	6,992	6,514	7,943	13,363	($51,584)
Overhead and General Expenses	19,985	16,753	20,325	19,503	( )
Interest	23,395	23,660	24,695	28,098	31,988
Renewal	12,866	12,966	13,120	14,531	16,193
Contingencies	210	278	325	335	375
Totals	$85,375	$78,252	$94,983	$101,307	$100,141

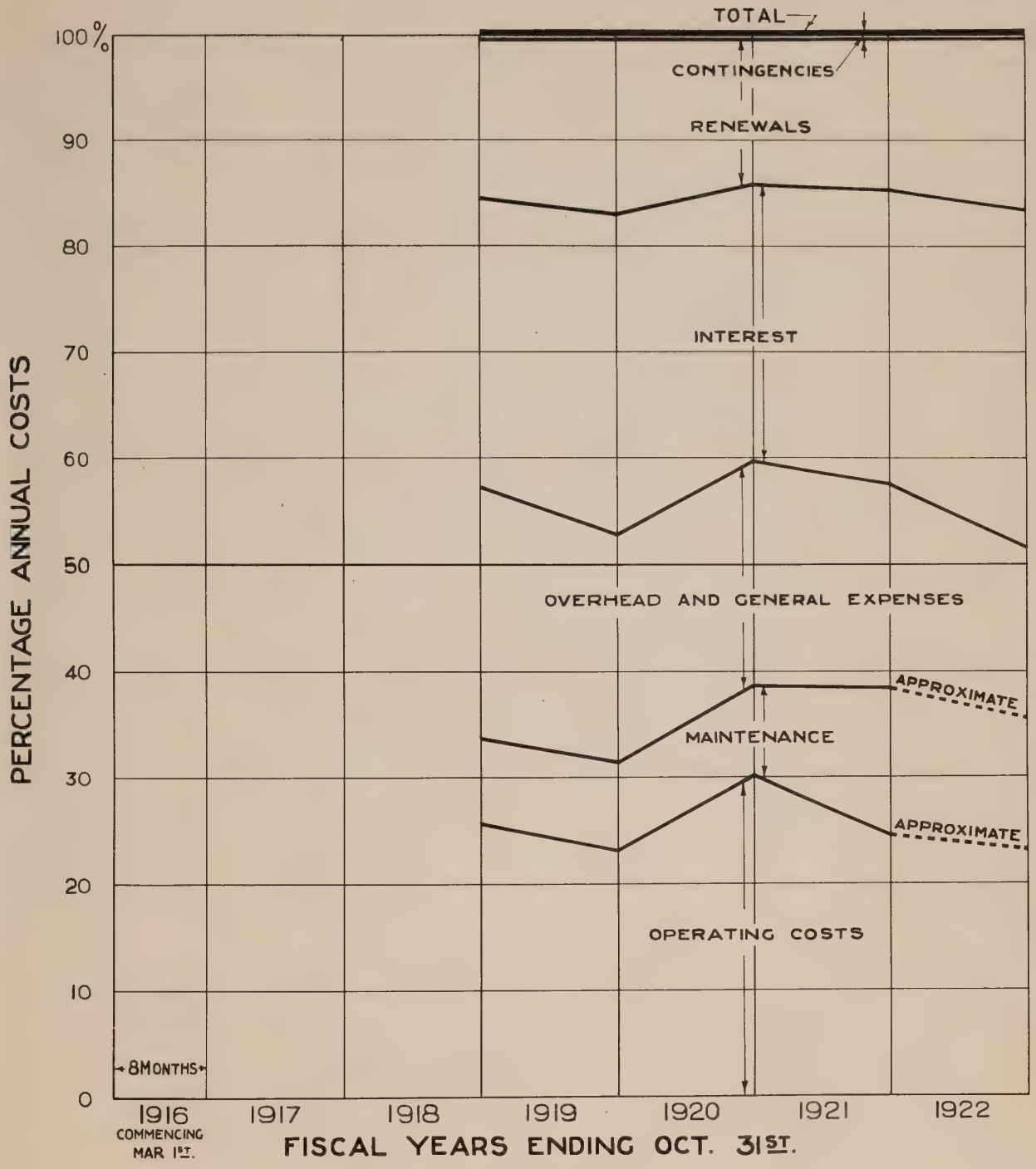
Percentage Costs of Power.

The sheet of curves included as page 32 shows the above figures plotted as percentages of the total costs of power per annum, and is included for comparison with other systems or with similar properties.

Analysis of Reserve Accounts.

Renewals Account.

On page 34 is shown a series of curves which indicate graphically the relation between that portion of the properties subject to physical deterioration in the electrical departments and the reserve fund for renewals which has been accumulated up to the present time. It being understood that the practice of the Hydro-Electric Power Commission is to spend sufficient money on



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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

ANNUAL COSTS SUBDIVIDED BY PERCENTAGES

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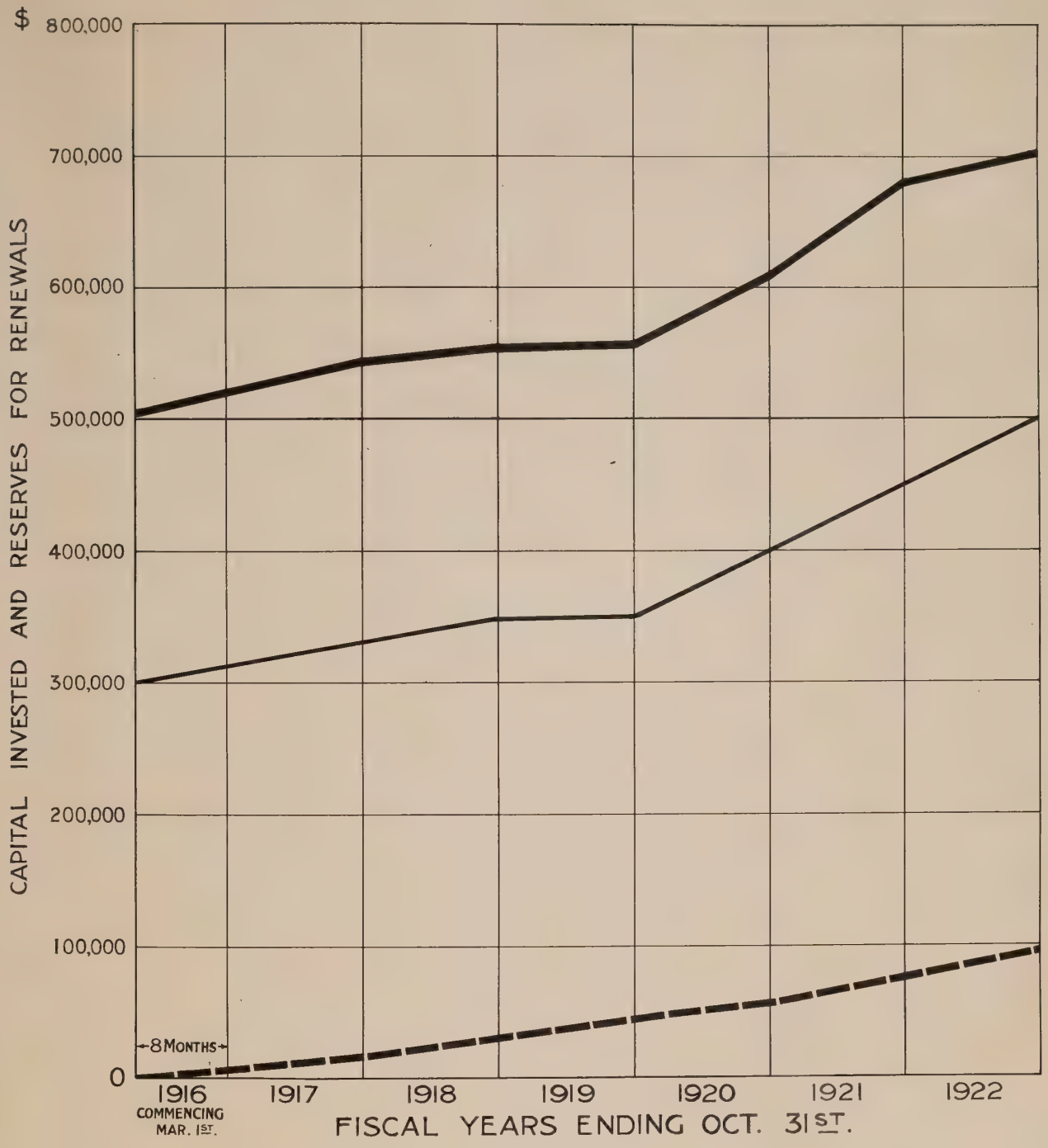
maintenance each year to keep the Section in a condition to operate in accordance with the requirements of economical production, stated to be about 75 per cent. as good as the original new condition, it was considered that the renewals account should be studied in connection with and applied to the renewal of only 25 per cent. of the depreciable capital concerned.

The methods indicated in Exhibits V, VI, VIa and VIb, of the Price, Waterhouse & Co. report, for setting aside a percentage of the depreciable capital each year on a sinking fund basis, are quite usual and are considered standard practice. Briefly stated the method is as follows:

The useful life in years of each portion of the depreciable capital invested is estimated, the replacement cost and the residual or scrap value of the articles at the end of this time are also estimated, and an amount is set aside which when compounded at an assumed earning rate will retire the total amount to be provided for at the end of its own particular useful life. Similar items are then grouped and an average figure found which will apply to the whole.

The capital cost for the depreciable portion of the Kipissing Section in 1915 was approximately $300,000, and at October 1922, was approximately $500,000, after having deducted the residual value of each item of the Section, and eliminating intangible values as well as lands and water rights which are not considered as deteriorating.

Taking into consideration the average period of service for this amount of capital and its estimated useful life, and allowing for the upkeep of the Section to about 75 per cent. of its original condition by means of the annual



TOTAL INVESTED CAPITAL THUS ▬▬▬

TOTAL APPROXIMATE DEPRECIABLE CAPITAL THUS ———

TOTAL RESERVES FOR RENEWALS, INCLUDING INTEREST, THUS ▬ ▬ ▬

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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

RESERVES FOR RENEWALS

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maintenance charges, it would appear that the total renewal fund to be provided for at the end of the useful life of the presently invested depreciable capital should be about $125,000. Inasmuch as the useful life of the Section is probably less than one-half completed, and as considerable capital expenditure has been made during the past year or two, and as there is a renewal account on the books of nearly $100,000 applicable to the Nipissing Section, it would appear that the accumulated renewal fund is larger than is necessary to replace that portion of the Section which would eventually require renewal, if the fund be augmented year by year and at the present rate compounded in the usual way.

During the past few months the various heads of departments of the Hydro-Electric Power Commission of Ontario have been studying the question of depreciation rates and the proper allowance for useful length of life for each kind of equipment, and they have come to the conclusion that the rates formerly allowed have been too high; in other words the actual deterioration of the various parts of the System have not been so great as was expected, and they have prepared figures to show that their former practice was too conservative in allowing for estimated useful life. They have, therefore, suggested that the renewal allowances on a sinking fund basis be considerably reduced in the annual charges. If this suggestion be adopted it would have the effect of building up the reserve fund in future at a slower rate, and of correspondingly reducing the annual costs, and consequently reducing the total annual cost of power.

There are one or two points which should receive careful consideration in dealing with the question of these reserves for renewals. One is the proposed

change in the estimated length of useful life of the various portions of the equipment, which will materially affect the annual allowances, and the other is the question of the proper rate of interest to be chosen in estimating the earning power of the invested reserve fund. A strict theory of the earning power of the renewal fund would take into consideration not only the method of investing the fund, for example, whether it be used in making extensions and betterments in the System as has actually been done, or invested in separate securities and treated like a trust fund, but also the rate of annual interest which should be adjusted each year in accordance with the actual value of money. The legal limitations of the allowable investment of the fund should also be kept in mind in this connection.

Sinking Fund.

No sinking fund has been provided to retire the ten-year bonds applicable to the purchase price of the Nipissing Section. It is therefore probably too late at this stage of operation to set aside any sinking fund which would retire the bond issue within the next three or four years. The question of refinancing the Nipissing Section will undoubtedly have to be included when the obligations concerning the whole of the Central Ontario System mature in 1926, and at that time the whole question of the provision of a sinking fund to retire the new bond issue, or other methods of financing, should be considered. It would appear to be good practice to provide such a fund.

The situation of the Nipissing Section is such that it would seem to lend

itself well to changing the ownership to a municipally-owned enterprise, if the North Bay people can finance the purchase. If this be done the usual sinking fund provisions would doubtless apply.

Reserve for Contingencies.

A study of the accounts of the Nipissing Section leads to the conclusion that the present reserve for contingencies, namely $1,524, is too small, and should be augmented by increasing the annual allowance for contingencies, and when a reserve of say $15,000 or $20,000 will have been built up the earnings can be re-adjusted to suit the conditions found after several further years of experience.

Discussion of Deficits and Surpluses.

The sheet of curves on page 30 indicates graphically the result of operations for the wholesale and retail electrical departments considered as one. One curve shows the total annual revenue, another curve shows the total annual costs of power, and the two curves near the datum line show respectively the annual resultant of operation and the accumulated resultant.

From the detail figures in Exhibits XVI, XVII and XVIII of the Price, Waterhouse & Co. report dated October 26th, 1922, it will be noted that the greater part of the fluctuations in operating costs in the years 1919 to 1921 inclusive have been caused by the operation of the auxiliary steam-power plant which was necessitated by the deficiency in the water supply, and in 1921 by a

temporary decrease in the output of the Nipissing plant during the re-modelling of one unit. It will be seen that the accumulated deficit shows a gradual increase up to 1921 largely due to steam plant operation as above noted, but this accumulated deficit shows a decrease in 1922 as a result of the profitable operations during that year, mainly owing to the steam plant not having been used.

The accumulated resultant to date shows that there is a total deficit of about $30,000 or about 5 per cent. or 6 per cent. as between the total revenues and the total costs during the period from 1916 to 1922, after having made provision for all operating costs and fixed charges and after having set aside approximately $100,000 for renewal account.

At the end of 1923 the Section will probably have added to its capital expenditures sufficient to bring the total investment to a figure in the neighborhood of $1,000,000. This will require a provision for fixed charges on an amount of about $300,000 or $350,000 in addition to the present investment. In order to offset the accumulated deficit it will therefore be necessary to reduce expenses and to find sufficient revenue not only to carry these additional fixed charges as well as the additional operating costs which will be necessitated by the development of Bingham site, but also a further amount. If the steam plant does not require to be operated, the indications are that the present unsupplied demand and the normal growth of the load in North Bay and the increased use of current by the existing consumers should soon be sufficient to provide for these additional operating costs and fixed charges. Careful attention must be given to operating the Section in order that these results may be quickly attained.

Consideration might be given to the adoption of a slight increase in rates to bring about this result more quickly.

Revenues and Costs per Horse-power per Annum.

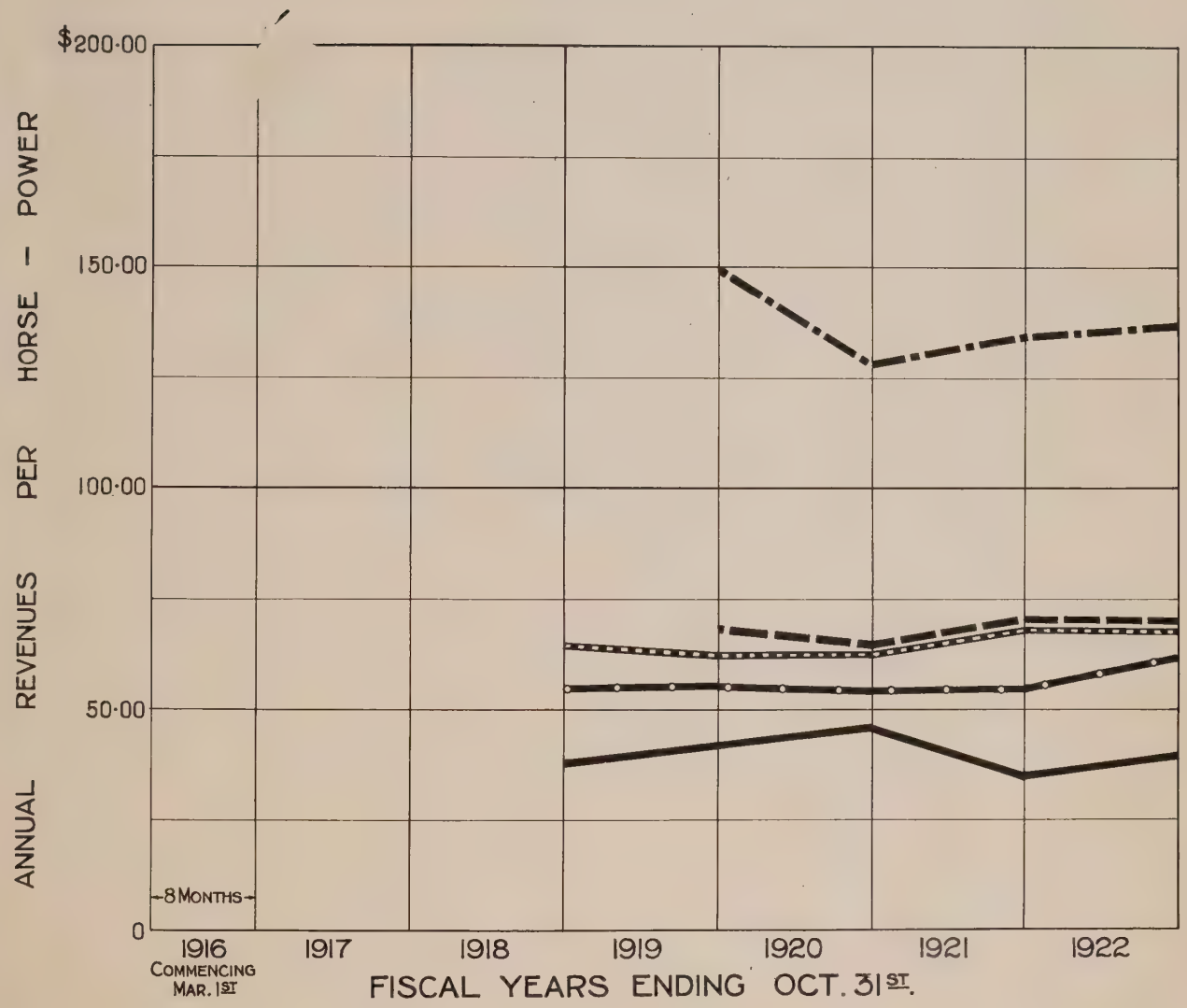
In order to reduce the total revenues and total costs for the electrical departments to a basis where these could be compared with those of other systems, sets of diagrams have been prepared to show these revenues and costs on a unit basis.

Annual Revenues per Horse-power.

The curves on page 40 entitled "Revenues per Horse-power per Annum for Various Horse-power Bases" are derived by dividing the total revenue by the different amounts of horse-power given on page 25. The table below shows the figures of revenues from which the curves were plotted.

Table of Revenues per Horse-power per Annum

	1918	1919	1920	1921	1922
Developed (including Steam Plant)	$ 38.20	$ 42.28	$ 46.47	$ 35.98	$ 40.15
Consumed	-	150.41	128.68	134.95	137.62
Billed	-	69.08	68.53	70.91	70.47
Average of Twelve Monthly Peaks	65.29	63.51	64.10	69.50	69.49
Maximum Yearly Peak	55.34	58.91	55.07	65.69	62.16



REVENUES PER H.P. CONSUMED
" " " - AVERAGE OF 12 MONTHLY PEAKS
" " " BILLED
" " " - MAXIMUM YEARLY PEAK
" " " DEVELOPED

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REVENUES PER H.P. PER ANNUM.
VARIOUS H.P. BASES

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For example, in 1921 the total revenue was $94,457.64, the horse-power developed including the steam plant was approximately 2,625 horse-power, and the revenue per horse-power per annum on this basis would therefore be $35.98. Similarly the horse-power consumed in 1921 was 700, and the revenue per horse-power consumed was therefore $134.95.

Annual Costs per Horse-power.

The tables on page 42 and the three sheets of curves following, being pages 43, 44 and 45, show the details of the costs per horse-power per annum on different bases. The figures from which the curves were plotted are the total figures for the operating costs given in the table on page 31 divided by the figures for the various classes of horse-power already given in the text. The sheet of curves included as page 43 indicates the total costs per horse-power per annum for the different classes of horse-power already described. For example, in 1921 the average cost per horse-power consumed is $144.72 and the average cost per horse-power developed including the steam plant is $38.59.

The sheet of curves on page 44 entitled "Sub-divided Costs per Horse-power Consumed per Annum" indicates the sub-division of the total annual costs as between operating, maintenance, overhead and general expense, interest, renewals, and contingencies, divided by the total amount of horse-power consumed on the Section. The sheet of curves included as page 45 is similar to that just described except that it is based on the horse-power developed including the steam plant and gives the annual costs on that basis. The figures forming the basis of the curves are as follows:

Table of Costs per Horse-power per Annum,
Various Horse-power Bases

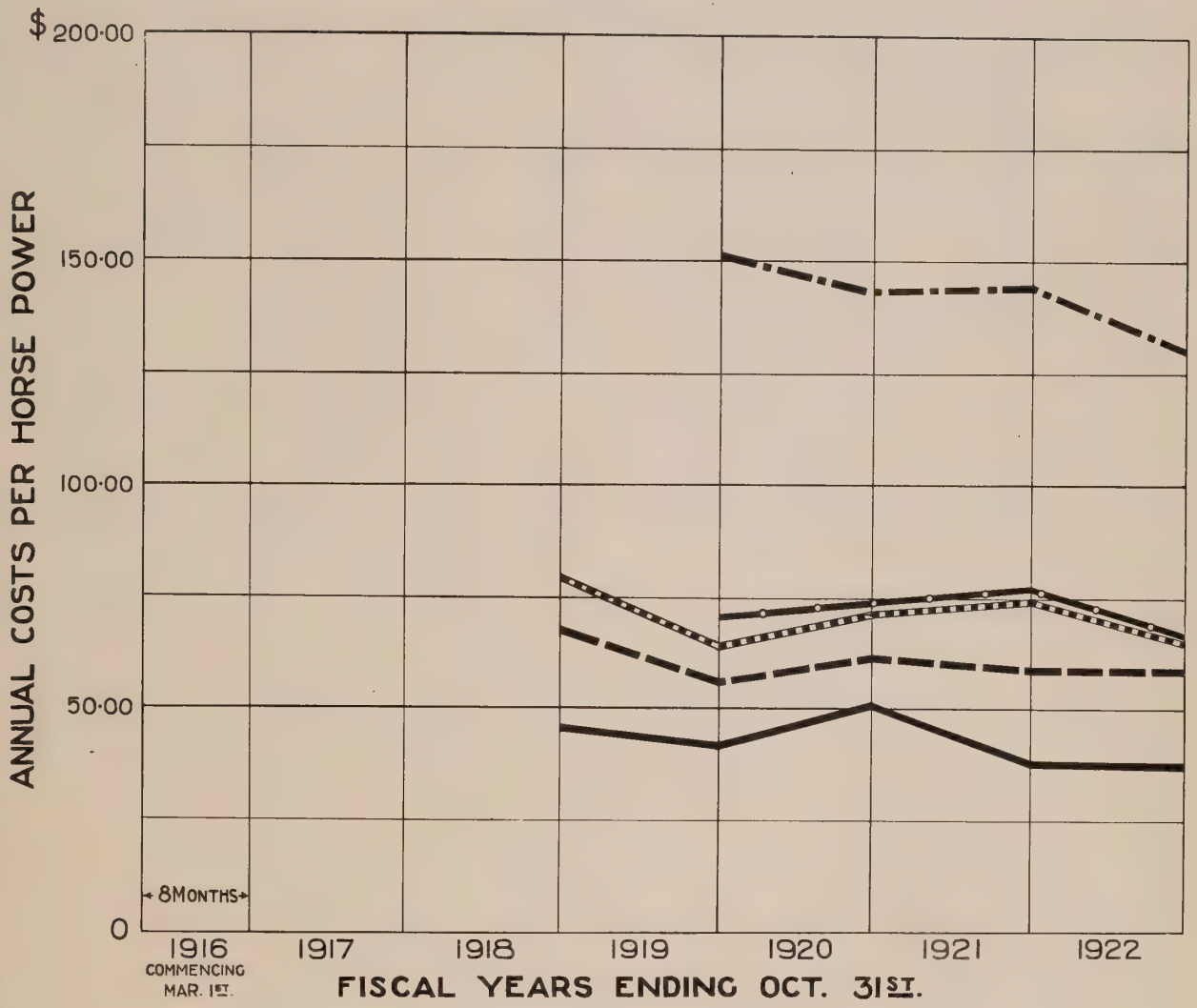
	1918	1919	1920	1921	1922
H.P. Developed	$ 46.78	$ 42.87	$ 52.04	$ 38.59	$ 38.15
H.P. Consumed	-	152.54	144.13	144.72	130.73
H.P. Billed	-	70.05	73.40	76.06	66.93
H.P. Average of Twelve Monthly Generated Peaks	79.94	64.40	71.79	74.55	66.01
H.P. Maximum Yearly Peak	67.75	56.70	61.58	59.73	59.04

Table of Sub-divided Costs per Horse-power Consumed

	1919	1920	1921	1922
Operating Costs	$ 55.24	$ 43.38	$ 35.89	( )
Maintenance	12.66	12.11	19.68	($ 67.46)
Overhead and General Expense	32.54	30.84	27.79	( )
Interest	46.22	37.47	40.23	41.70
Renewals	25.17	19.90	20.69	21.05
Contingencies	0.61	0.43	0.44	0.52
Total	$152.54	$144.13	$144.72	$130.73

Table of Sub-divided Costs per Horse-power Developed

	1918	1919	1920	1921	1922
Operating Costs	$ 12.02	$ 9.90	$ 15.66	$ 9.57	(
Maintenance	3.84	3.56	4.37	5.25	($ 19.69
Overhead and General Expense	10.95	9.17	11.14	7.41	(
Interest	12.82	12.99	13.53	10.73	12.17
Renewals	7.06	7.08	7.18	5.52	6.14
Contingencies	0.09	0.17	0.16	0.11	0.15
Total	$ 46.78	$ 42.87	$ 52.04	$ 38.59	$38.15



Cost Per H.P. Consumed
" " " " Average of 12 Monthly Peaks
" " " " Billed
" " " " Maximum Yearly Peak
" " " " Developed

Hydro-Electric Inquiry Commission
W. D. Gregory, Chairman

Economics of H. E. P. C. Distribution Systems

Central Ontario System

Nipissing Section

COSTS PER H.P. PER ANNUM, VARIOUS H.P. BASES

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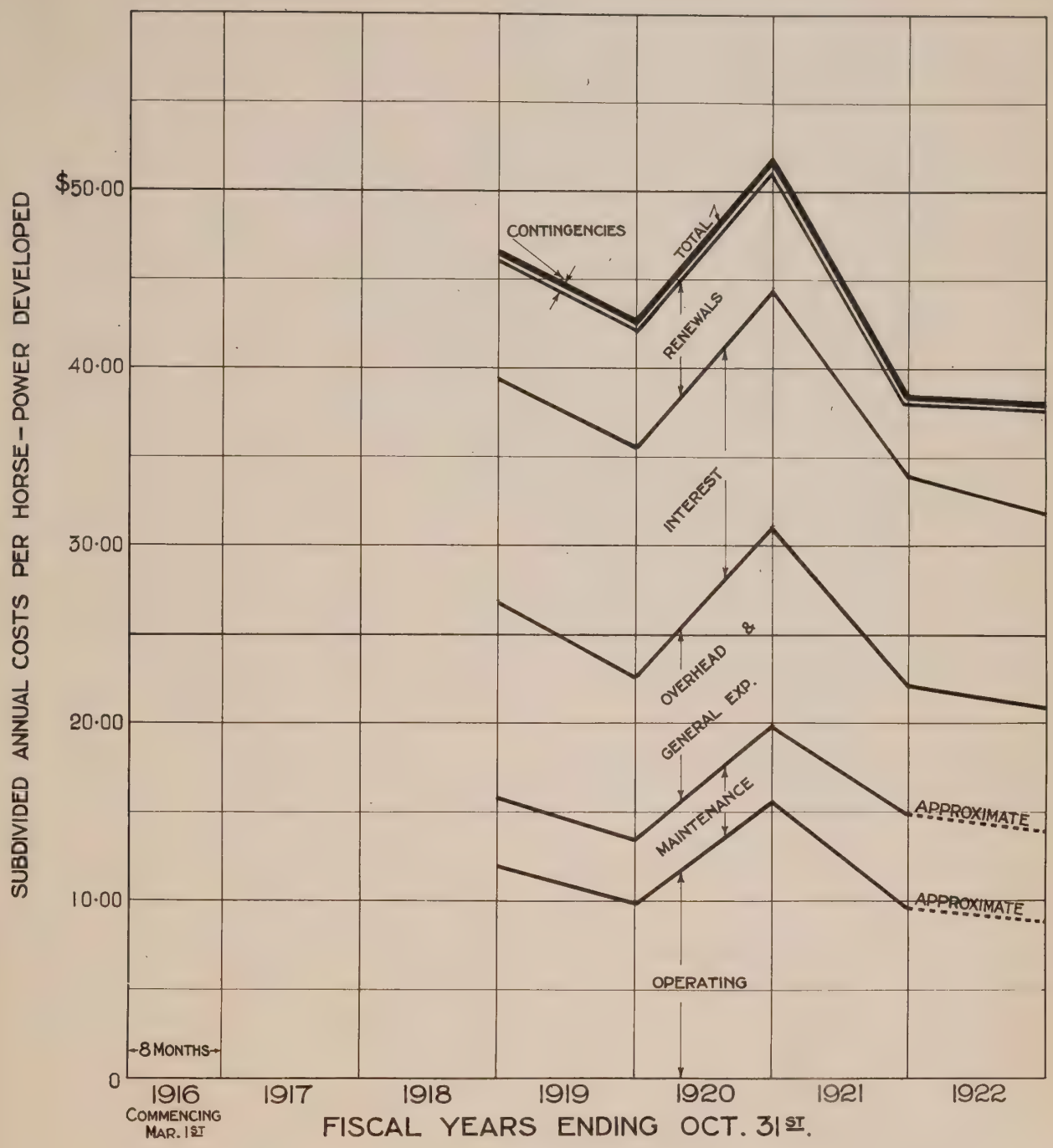

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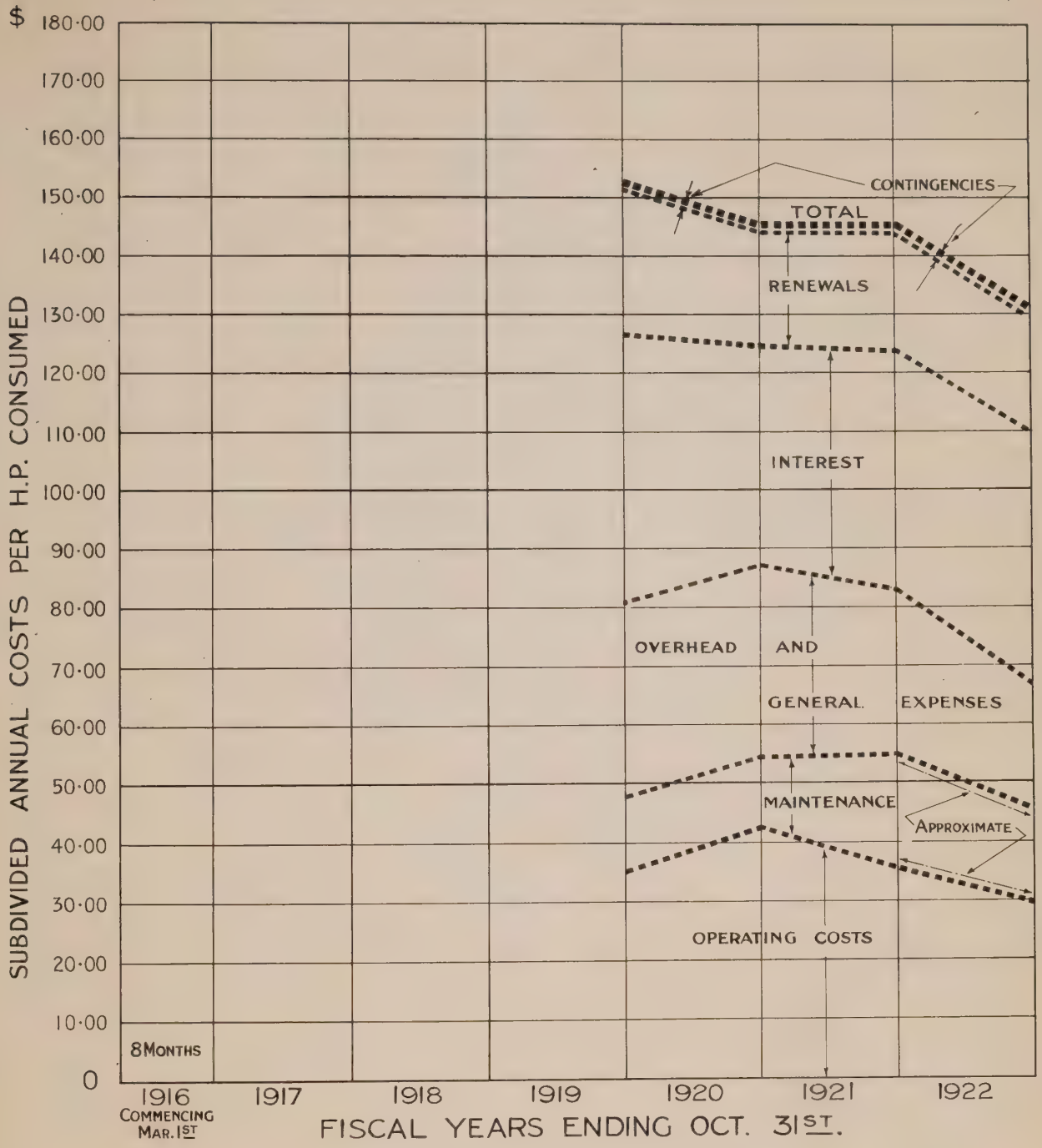
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
CENTRAL ONTARIO SYSTEM
NIPISSING SECTION

SUBDIVIDED COSTS PER H.P. DEVELOPED PER ANNUM

Toronto, Jan. 12th. 1923., Made by G.E.R. Checked by L.A.H.
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

SUBDIVIDED COSTS PER H.P. CONSUMED PER ANNUM

Toronto, Jan. 12th., 1923, Made by S.R.W. Checked by C.L.F.

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Kilowatt-hour Data and Annual Revenues and Costs per Kilowatt-hour.

Kilowatt-hours Consumed.

The officials of the Hydro-Electric Power Commission have supplied a complete record of the kilowatt-hours consumed for the Nipissing Section for each fiscal year ending October 31st, up to and including 1922. The following table shows the number of kilowatt-hours used per consumer in each of the municipalities served for each year from 1919 to 1922. A sheet of curves showing the average kilowatt-hour per consumer and the average revenues per consumer derived from the above table, and from the total revenues, is included on page 47.

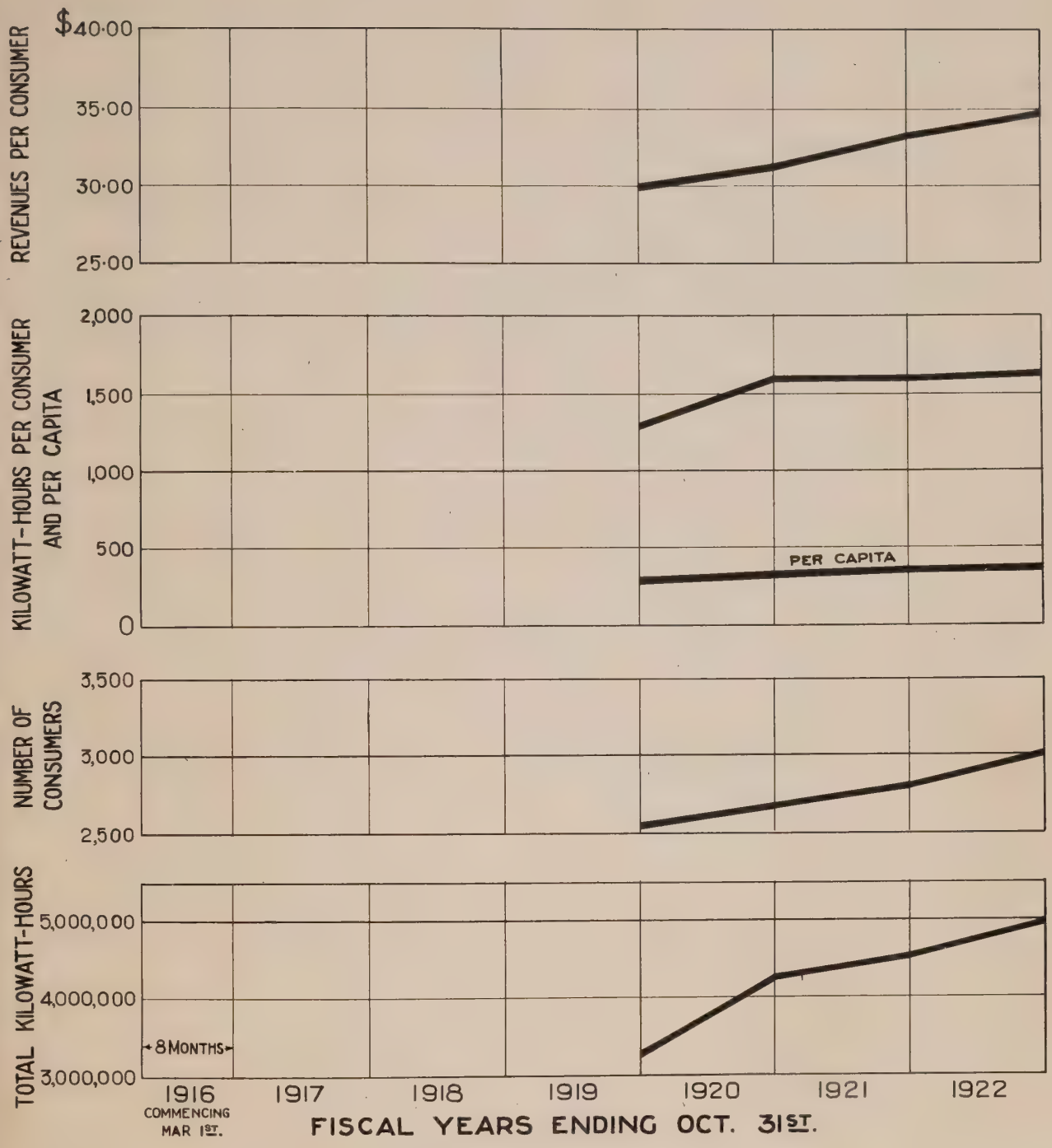
COPY

Table of Kilowatt-hours per Consumer

	1919	1920	1921	1922
North Bay	3,189,600	4,088,100	4,318,066	4,779,079
Callander	52,300	49,560	70,240	86,900
Powassan	110,500	155,800	178,040	132,820
Nipissing	4,635	5,047	5,420	5,550
Total Consumed	3,357,035	4,298,507	4,571,766	5,004,349
Total Generated	-	-	5,426,596	6,238,660
Total Population	10,692	11,423	12,273	13,117
Total Number of Consumers	2,558	2,699	2,827	3,024
Kilowatt-hours per Consumer	1,312	1,593	1,618	1,654
Revenue per Consumer	$30.16	$31.42	$33.41	$34.85

Revenues per Kilowatt-hour.

From the total kilowatt-hour figures and the total revenues in dollars, a curve has been plotted showing the income per kilowatt-hour, and this result is



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

KILOWATT-HOUR DATA

Toronto, Jan. 12th., 1923 Made by [illegible] Checked by [illegible]

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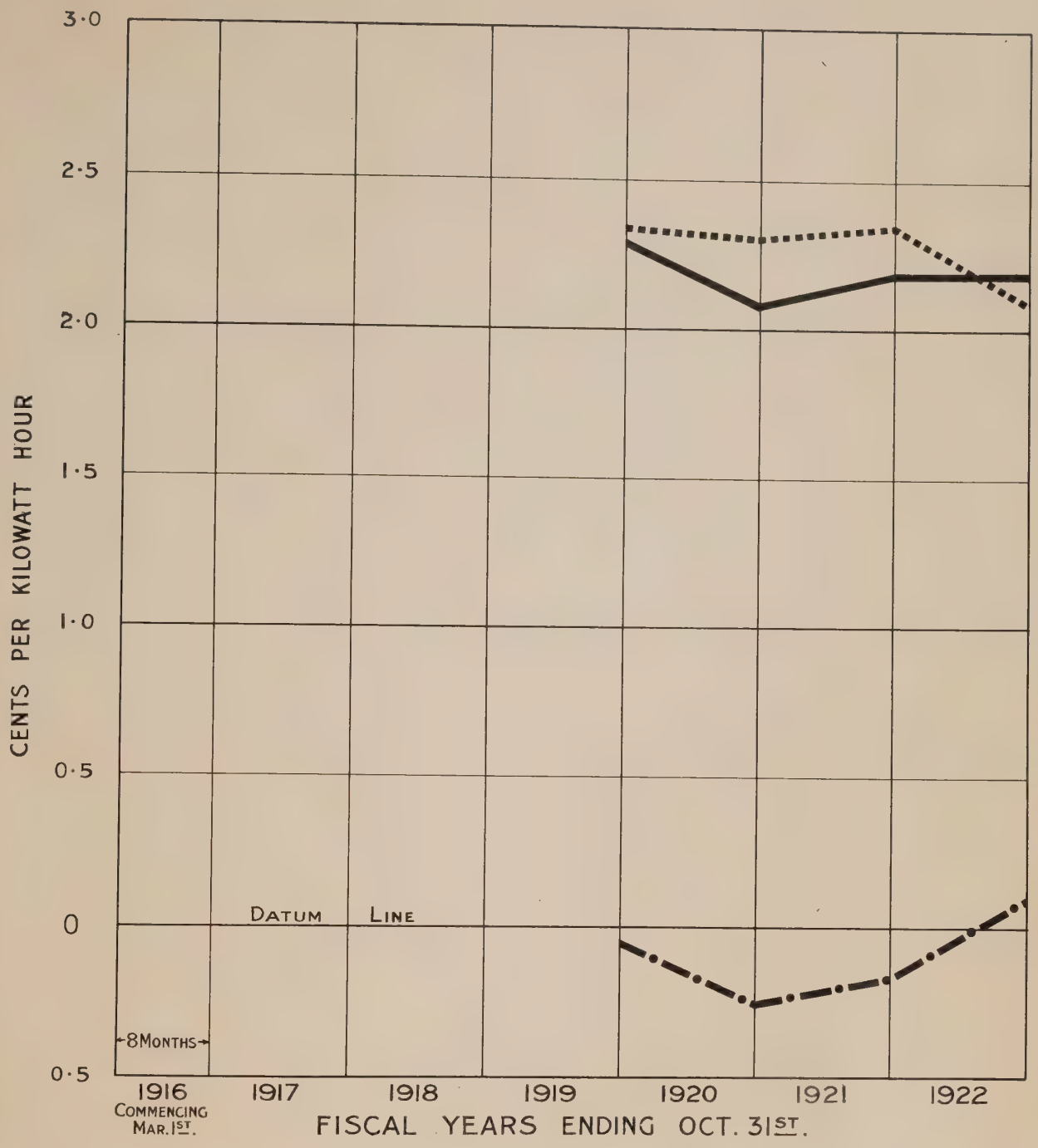

COSTS PER K.W.H. ▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪

REVENUES " " ━━━━━━━━━━

SURPLUS OR DEFICIT PER K.W.H. ━•━•━•━

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

CENTRAL ONTARIO SYSTEM

NIPISSING SECTION

REVENUES, COSTS, SURPLUSES OR DEFICITS, PER KILOWATT HOUR

Toronto, Jan. 12th. 1923. Made by S.R.W. Checked by L.H.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

shown graphically on one of the curves included as page 48.

Costs per Kilowatt-hour.

A second curve on the sheet included as page 48 shows the average total costs per kilowatt-hour for each year, the figures being derived from the total costs divided by the total kilowatt-hours.

Results of Operation per Kilowatt-hour.

The third curve on the sheet included as page 48 shows the annual total results per kilowatt-hour. This curve is the one near the zero or datum line and shows the net annual resultant of operations. An examination of this latter curve indicates that the operations of the electrical department have been carried on at a small loss per kilowatt-hour in nearly every year, but that 1922 is showing a small profit.

Summary.

A summary of a number of the more salient points which have been studied and discussed in the foregoing report may be of advantage in continuing the consideration of the economics of the Nipissing Section of the Central Ontario System. They are as follows:

(1) The capital costs of the electrical department show a total charge for intangible values of about $98,000. Apparently no separate allowance has been made for the capital value of the undeveloped power sites on the South River, and the information so far submitted does not indicate definitely the rights of the Provincial Government in the undeveloped power sites. Consideration should be given to the question of amortization of

the intangible values.

(2) The capital costs of the extensions to power plants, transformer stations and main lines made by the Government since taking over the System in 1916 have apparently been based primarily on maximum physical efficiency, long life and uninterrupted service rather than on the usual commercial conditions for a privately owned enterprise.

(3) To facilitate economic studies, and to assist in increasing the efficiency of operation, records of kilowatt-hours generated or used at each principal consuming point and at all generating plants on the System should be maintained, where such is not already being done.

(4) The market conditions in North Bay are peculiar. The stove load is apparently taxing the distribution system and the available power considerably. The density of load indicates a probable normal growth at rates which would require several years to take up the capacity of the re-modelled Nipissing plant and the proposed Bingham development. The demand for power is growing, however, and if extraordinary loads are offered, consideration must be given to the development of at least two other power sites on the South River and of two sites on the French River.

(5) The reserve for renewals should be carefully considered in its relation to the recently revised estimated useful life for various portions of the property, and also adjusted to allow for the actual cost of money year by year. The present reserve for this purpose amounts to about $100,000.

(6) The question of sinking fund should be studied having in mind the possible purchase of the whole Nipissing Section by the local municipalities. When the present bond issue matures for the whole Central Ontario System in 1926, the question of sinking fund for the re-financing of the two Sections should also receive consideration.

(7) The reserve for contingencies should be considered in its relation to the total capital invested, and the possibility of calling upon this fund for extraordinary uses.

(8) The results of operations indicate that considerable expense has had to be borne due to the lack of development of water power and the consequent necessity of operating the steam plant at high costs, causing an annual deficit in each year except 1922, when a small operating profit was made. The net result of operations to date is that the summation of the total annual revenues is less than the summation of the total annual costs by 5 per cent. or 6 per cent.

Walter J. Francis

Consulting Engineer.